Turkish Journal of Veterinary & Animal Sciences

Volume 45 | Number 5 Article 17

1-1-2021

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Turkish Journal of Veterinary and Animal Sciences

http://journals.tubitak.gov.tr/veterinary/

Research Article

Turk J Vet Anim Sci
(2021) 45: 936-943
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doi:10.3906/vet-2011-66

Effects of age at feedlot entry on performance, carcass characteristics, and beef quality traits of Holstein Friesian bulls reared in high altitude of Eastern Turkey

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Received: 18.11.2020 • **Accepted/Published Online:** 06.10.2021 • **Final Version:** 26.10.2021

Abstract: The objective of this research was to determine the effects of different initial fattening ages on the fattening performance, carcass features, and meat quality traits of Holstein Friesian bulls. A total of 24 Holstein-Friesian intact males were used in the study. The bulls were allocated to the initial fattening age groups named as Young Group (8–10 months old) (YG), Middle Aged Group (12–14 months old) (MAG) and Older Group (15–17 months old) (OG) and then placed in the feedlot based on three age groups at feedlot entry. The data that has normal distribution were analysed by using the LSMM in GLM, while others were analysed by using the nonparametric Kruskal - Wallis H test. The average daily weight gain of the YG, MAG and OG were 1.09 ± 0.27 kg, 1.01 ± 0.48 kg and 0.95 ± 0.60 kg ($p < 0.01$), respectively. Additionally, YG was the most effective group in terms of feed efficiency ratio (FER) compared to others. However, carcass measurements and carcass weight had lower values in the YG. Effects of age at feedlot entry had also insignificant effect on the carcass traits. Besides, measurements of the carcass muscularity including area of *Musculus longissimus dorsi* (MLD), SEUROP carcass conformation scores of the bulls in the MAG, and OG were superior to Holstein Friesian bulls in the YG. Different initial fattening ages had no significant effects on the chemical composition of MLD samples except for percentage of protein value. In conclusion, taking animals into feedlot at early ages resulted in accelerated weight gain, higher marbled meat, and improvement of the FER of Holstein Friesian bulls reared in harsh environmental conditions of the Eastern Turkey. However, the young animals had the lowest carcass weights and carcass measurements along with muscularity parameters.

Key words: Initial fattening age, carcass traits, beef composition, beef quality

1. Introduction

Beef is one of the important parts of the human diet and provides a rich source of essential nutrients and high biological value protein, some of which are more bioavailable than in other food sources [1]. Thus, in recent years, beef production has become increasingly important in livestock industry of Turkey, and 1,201,469 tons of beef (89.5% of the red meat production) was produced annually in the country [2].

Mountainous Eastern Region of Turkey is a unique part of the country regarding cattle husbandry. The region has also about half of the fruitful meadow and pasture areas of the country. Therefore, about 20% of the cattle population of Turkey is reared in this area. The average altitude of the region varies from 1500 to 2000 m on average. Especially during winter season, average temperature is around –10 °C, and furthermore, the temperature could sometimes drop to –20 °C and it snows a lot.

Approximately 60 years ago, pregnant Holstein Friesian heifers were first imported from the USA, and then importation of the female animals have been continued from European countries including Italy up to recent years. Roughly, four decades ago, Holstein Friesian cattle were brought to the Eastern Region of Turkey to increase milk production, although Holstein Friesian is a lowland breed and Eastern Turkey has more harsh climatic conditions than their homeland climatic conditions. Nowadays, the breed is one of the most common European cattle breeds in the Eastern Turkey. Holstein Friesian cattle in this region have distinctive morphological characteristics concerning body size and body weight. Result of a study conducting on this breed reared in mountainous Eastern Region of Turkey revealed that individuals of the Holstein Friesian at the same age were noticeably lighter and had smaller frame size than their counterparts in other European countries [3].

In the Eastern Region of Turkey, surplus Holstein Friesian males are used for fattening purposes. Beef production in this area is generally done based on traditional methods, which disregarded at feedlot entry,

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breed of the animals, differences in genetic composition, concentrate level, slaughter end points, gender, housing conditions, etc. [4]. These factors could result in significant variations on the fattening performance and carcass quality parameters. Ustuner et al. [5] also reported critical roles of the age at feedlot entry in the evaluation of effectiveness of the fattening of Simmental cattle besides carcass characteristics. In the literature, some comparisons have been made on the effects of duration of the fattening, slaughter age and different fattening systems on fattening performance traits and carcass qualities of cattle raised in this region [6–9]**.** However, there is limited information about the effects of different initial fattening ages on these traits, especially for Holstein Friesian bulls reared in high altitude and harsh climatic conditions. Therefore, the study was carried out to reveal the effect of age at feedlot entry on the fattening, slaughter, and carcass features as well as meat quality traits of Holstein Friesian bulls.

2. Materials and methods

The research was carried out in the Food and Livestock Application and Research Center of Atatürk University, Erzurum, Turkey. The study was conducted between fall and end of the spring seasons. Averages of the ambient temperature, relative humidity as well as precipitation during the fattening period were 6.1 C, 63.2%, 49.9 mm, respectively. A total of 24 Holstein-Friesian intact males were used in the current research. The bulls were allocated to the initial fattening age groups named as Young Group (8–10 months old) (YG), Middle Aged Group (12–14 months old) (MAG) and Older Group (15–17 months old) (OG) and then placed in the feedlot based on three age groups at feedlot entry. Eeach of 2 day at the start and end of the fattening trail, the young bulls were weighed at following 12 h starvation. The averages of the weights were calculated and noted as the initial and final weights. Data concerning individual daily weight gain and feed efficiency ratio of each treatment group were also obtained during the fattening period. The bulls were fattened in a closed free-stall barn, and group feeding was practiced. Amount of area dedicated for each treatment groups was about 80 m^2. Amounts of feed offered to the three experimental groups were determined according to the average weights of the groups obtained at 14 day-intervals during the experiment. Bulls consumed a diet consisting of 65% concentrate and 35% dry hay. The animals were adapted gradually to the ration over 2 weeks.

Fattening animal groups were kept in different sections of a feedlot and fresh water was provided ad libitum from the water containers in each compartment. During the fattening period, the cattle were fed twice a day. Remained feed in the feeders was weighed daily, and the amount of feed consumed for 1 kg live weight gain (LWG) was calculated for each group. Fattening lasted for 258 days. The chemical compositions of the dry hay and concentrate used in this study are determined and presented in Table 1 [10].

For the slaughtering process, animals were moved to slaughterhouse of Erzurum Meat and Milk Board. All Holstein Friesian bulls were slaughtered conventionally in this state-owned slaughterhouse. Head, feet, hide, lungs, liver, testis, tail, spleen, heart, kidneys as well as pelvic fat, heart fat, and kidney fat were obtained and weighed immediately after the slaughter. Hot carcass weight was also recorded. Dressing percentages of hot and cold carcasses were calculated as ratio of hot or cold carcass weights to slaughter weight that was live weight obtained in slaughterhouse.

Following the slaughter procedure, the carcasses were chilled in the cold storage room (+ 4 °C) for 24 h. The carcass halves were ribbed and graded by two trained carcass evaluators [11]. The ribbing site was at the 12th and 13th rib interface. Marbling and color scores were also ascertained at the ribbing site. The scale used for determination of marbling score varied from 1 to 18 (1: slight$^-$, 2: slight^0, 3: slight$^+$, 4: small$^-$, 5: small^0, 6: small$^+$, 7: modest$^-$, 8: modest^0, 9: modest $^+$, 10: moderate$^-$, 11: moderate^0, 12: moderate$^+$, 13: slightly abundant$^-$, 14: slightly abundant^0, 15: slightly abundant$^+$, 16: abundant$^-$, 17: abundant^0, 18: abundant$^+$). Color score was obtained by using Standards for Beef Color, developed by New Mexico State University Agricultural Experimentation Station, USA [12]. The scale of color evaluation ranged from 1 to 8 (1: bleached red, 2: very light cherry red, 3: moderately light cherry red, 4: cherry red, 5: slightly dark red, 6: moderately dark red, 7: dark red; 8: very dark red). Meat samples from MLD were also taken from regions of the 11th and 12th ribs of the carcasses at 24 h post-mortem.

After 24 h post-mortem, the left halves of the carcasses were scored subjectively for carcass conformation [scale SEUROP, from S: superior (1), E: excellent (2), U: very good (3), R: good (4), O: fair (5) to P: poor (6)] and carcass fatness (scale 1-5, from 1: none or low fat cover, 2: slight, 3: average, 4: high, to 5: entire carcass covered with fat) by utilizing photographic patterns according to the routinely used by European Union SEUROP classification system [13].The USDA yield grades (a numerical value from 1 to 5 based upon the yield of boneless, closely trimmed retail cuts from round, loin, rib and chuck of the beef carcass) and cutability (the proportion of boneless, trimmed, saleable retail cuts of meat obtained from carcass) were also determined by using a mathematical equation indicated by Boggs and Markel [14].

LD muscle samples taken from each carcass were cooked in a water bath at 90 °C until the internal temperature reaches 70 °C. Mechanical assessment of tenderness of the meat samples cooled to 20 °C was also performed by using

Table 1. Chemical compositions of the feed

Nutrients	Concentrate	Dry Hay
Dry Matter (%)	88.6	92.8
Crude Protein (%)	17.1	9.2
Crude Cellulose (%)	12.8	30.8
Crude Ash (%)	8.7	8.9
Ether Extract (%)	2.2	3.0
ADF (%)	20.4	38.2
NDF(%)	39.8	64.7
Metabolic Energy (kcal/kg)	2856.3	1713.4

ADF: Acid detergent fiber, NDF: Neutral detergent fiber

the Warner Bratzler Shear Force (WBSF) device [15].

Carcass length, length of round, width of the round from lateral and medial sides as well as chest depth were also taken as indicated by Ozluturk et al. [16]. Raw MLD samples were analyzed chemically according to the methods described by Ockerman [15] for protein, dry matter, fat, and ash contents.

The data obtained in this study were first subjected to normality test in SPSS statistics computer program in order to ensure the normal distribution of data. The data were analyzed by using the LSMM in GLM [17].The Duncan Multiple Comparison Test was used for comparison of subclass means when F test for main effect was significant. Normally distributed data were statistically analyzed by a statistical model that included ages at feedlot entry (8–10 months, 2; 12–14 months, 3;15–17 months) as main effect. Some of data regarding with marbling scores, percentages of liver, Kidney+pelvic+heart (KPH), tail and kidney weights as well as subcutaneous fat thickness were not normally distributed. The data that did not have normal distribution were statistically analyzed by using Kruskal Wallis nonparametric test, and Mann Whitney U test was also utilized for dual comparisons of the subgroups of the main factors. The nonparametric tests were also performed by using SPSS statistics computer program [17].

3. Results

The differences of final weights of the bulls that entered the feedlot at 8-10 m of age (YG), 12-14 months of age (MAG) and 15-17 months of age (OG) were statistically significant ($p < 0.05$). Final weights of the OG were 6.4% and 19.8% superior to the MAG and YG, respectively. In addition, final weight of the MAG was 14.3% superior to the YG (Table 2). However, the different ages at feedlot entry did not have statistically significant effects on the daily and total weight gains.

Maximum daily feed intake was observed in the OG with 10.76 kg, followed by the MAG group with 9.87kg, and the lowest feed consumption was found out in the YG with an average of 8.74 kg per day (Table 3). Since the group feeding was performed in this study, statistical comparisons of the treatment groups in terms of daily feed intake and average feed efficiency ratio values could not be made.

There were significant ($p < 0.01$) differences in favor of MAG and OG for hot and cold carcass weights as well as slaughter weights. However, insignificant differences among the initial fattening age groups for hot and cold carcass dressing percentage values were determined (Table 4).

Most of the carcass traits, such as SEUROP conformation scores, yield grades, cutability, WBSF values, beef color scores and cooking loss values except for MLD areas and MLD area per 100 kg carcass weight were not significantly affected from ages of the bulls at feedlot entry (Table 5).

On the other hand, initial fattening ages have significant ($p < 0.01$) effect on the area of MLD as well as MLD area per 100 kg carcass weight. Comparing carcass fatness parameters, such as percentage of KPH fat, SEUROP fatness scores, subcutaneous fat thickness over MLD, and marbling scores revealed no statistically significant differences among the treatment groups.

None of the percentage of the noncarcass components was affected significantly by initial fattening ages, except for percentages of the liver and hide weights (Table 6). While carcass length, chest depth, and length of round values were greater ($p < 0.01$) in MAG and OG compared to YG, the width of the round from medial side of the carcasses in the YG was significantly ($p < 0.05$) lower than others (Table 7). However, width of the round from lateral side was not affected significantly by feedlot entry ages.

All the chemical analyses of MLD samples were not affected by ages of Holstein Friesian bulls at feedlot entry except for percentage of protein (Table 8). Percentage of protein of the meat from the OG was significantly ($p < 0.01$) higher than other initial fattening age groups.

4. Discussion

Initial fattening weights of Holstein Friesian bulls at 8–10 months, 12–14 months, and 15–17 months of ages were lower than weight standards of Holstein Friesian Breed Association in the present study [18]. The lower live weights of the Holstein Friesian cattle in the Eastern Region of Turkey comparing to their counterparts could be attributed to the environmental differences with regard to climate and geographical conditions between the homeland of the breed and Eastern Turkey. Various ages of the bulls at feedlot entry had significant effects ($p < 0.05$) on the final weights, and the finding of the present study

Table 2. Least square means and standard errors for fattening performance traits of Holstein Friesian bulls

Performance Traits	Young Group N=6 $\bar{X}\pm S_{\bar{X}}$	Middle Aged Group N=10 $\bar{X}\pm S_{\bar{X}}$	Older Group N=8 $\bar{X}\pm S_{\bar{X}}$	Significance
Fattening period (d)	258	258	258	
Initial weights (kg)	200.0±13.2^{c}	302.1±10.8^{b}	353.8±14.1^{a}	**
Final weights (kg)	481.0±19.2^{b}	561.5±16.8^{a}	600.0±20.9^{a}	**
Total weight gains (kg)	281.0±7.2	259.4±12.4	246.3±15.7	ns
Daily weight gains (kg)	1.09±0.27	1.01±0.48	0.95±0.60	ns

**: P<0.01, ns: Nonsignificant, ^{a,b}: Means followed by a different letter within a line are statistically different.

Table 3. Least square means for average feed intake and feed efficiency ratio of Holstein Friesian bulls[1]

	Young Group N=6	Middle Aged Group N=10	Older Group N=8
Average Daily Feed Intake (Dry Matter Basis)			
Dry Hay (kg)	3.76	4.45	4.87
Concentrate Feed (kg)	4.99	5.42	5.89
Amount of Total Feed (kg)	8.74	9.87	10.76
Feed Efficiency Ratio[2]			
Dry Hay (kg)	3.46	4.10	4.48
Concentrate Feed (kg)	4.57	4.98	5.40
Amount of Total Feed (kg)	8.03	9.07	9.89

[1]Since the bulls were fattened in a free-stall barn and group feeding was practiced, individual daily feed intake and feed efficiency ratio values could not be determined. Therefore, statistical comparisons were not able to be done, and the mean values given in the table belonged to the averages of all animals in each treatment group.
[2]Feed Efficiency Ratio: Amount of Feed Consumed per kg Weight Gain (Dry Matter Basis)

Table 4. Least square means and standard errors for slaughter characteristics of Holstein Friesian bulls

Slaughter Characteristics	Young Group N=6 $\bar{X}\pm S_{\bar{X}}$	Middle Aged Group N=10 $\bar{X}\pm S_{\bar{X}}$	Older Group N=8 $\bar{X}\pm S_{\bar{X}}$	Significance
Slaughter Weights (kg)	471.3±18.5^{b}	550.0±16.2^{a}	587.4±20.6^{a}	**
Hot Carcass Weights (kg)	258.6±11.8^{b}	305.5±10.3^{a}	333.0±14.3^{a}	**
Cold Carcass Weights (kg)	255.1±11.9^{b}	301.0±10.1^{a}	328.0±14.1^{a}	**
Hot Carcass Dressing Percentage (%)	53.7±0.5	54.2±0.5	55.3±0.6	ns
Cold Carcass Dressing Percentage (%)	52.9±0.5	53.4±0.5	54.5±0.6	ns

**: P<0.01, ns: Nonsignificant, ^{a,b}: Means followed by a different letter within a line are statistically different.

was in accordance with the results reported by Bozkurt and Dogan [19], Güngör et al. [20] and Özdoğan [21]. Although the initial weight of the groups at the beginning of the fattening were significantly ($p < 0.01$) different from each other, these differences do not significantly affect the total and daily weight gains as previously indicated by Diler et al. [22] and Mundan et al. [23].

While maximum total weight gain was observed in the YG, the lowest total weight gain was obtained from bulls in the OG. Similarly, the highest daily weight gain (1.09 kg) was obtained from the YG, and it was followed by the MAG with 1.01 kg and the OG with 0.95 kg. However, these differences were not statistically significant. Comparable results regarding with average daily weight

Table 5. Least square means and standard errors for carcass characteristics of Holstein Friesian bulls

Carcass Characteristics	Young Group N=6 $\bar{X}\pm S_{\bar{X}}$	Middle Aged Group N=10 $\bar{X}\pm S_{\bar{X}}$	Older Group N =8 $\bar{X}\pm S_{\bar{X}}$	Significance
Colour Scores	5.75±0.38	5.90±0.16	5.56±0.11	ns
Marbling	2.33±0.56	1.40±0.16	1.88±0.23	ns
SEUROP Fatness Scores	1.83±0.21	1.50±0.20	1.82±0.16	ns
SEUROP Conformation Scores	9.5±0.9	10.3±0.6	11.3±0.9	ns
MLD[1] Areas (cm^2)	74.4±2.3[b]	77.2±2.7[b]	86.4±2.1[a]	**
Fat Thickness Over MLD (mm)	5.13±1.66	3.88±0.50	4.93±0.57	ns
MLD Areas per 100 kg Carcass Weight (cm^2)	29.7±0.8[a]	25.2±0.5[b]	26.1±0.6[b]	**
WBS (lb)[2]	5.56±0.76	6.20±1.29	6.12±1.68	ns
Yield Grades	1.70±0.31	1.77±0.31	1.66±0.31	ns
Cutability (%)	53.1±0.8	52.9±0.7	53.1±0.7	ns
Cooking Loss (%)	30.6±2.0	31.5±1.3	28.5±1.2	ns
Kidney Fat Weight[3] (%)	0.12±0.01	0.10±0.01	0.10±0.01	ns
Pelvic Fat Weight[3] (%)	0.99±0.07	0.69±0.05	0.76±0.15	ns
Kidney Pelvic Heart (KPH) Fat[3] (%)	1.11±0.08	0.77±0.05	0.86±0.15	ns

[1]MLD: *Musculus longissimus dorsi*, [2]WBSF: Warner Bratzler Shear Force, [3]The weights were expressed as a percentage of carcass weight, **: P<0.01, ns: Nonsignificant, [a,b]: Means followed by a different letter within a line are statistically different.

Table 6. Least square means and standard errors for noncarcass components[1] of Holstein Friesian bulls

Noncarcass Components	Young Group N=6 $\bar{X}\pm S_{\bar{X}}$	Middle Aged Group N=10 $\bar{X}\pm S_{\bar{X}}$	Older Group N=8 $\bar{X}\pm S_{\bar{X}}$	Significance
Hide Percentage (%)	7.92±0.10[a]	7.75±0.15[ab]	7.31±0.15[b]	*
Head Percentage (%)	3.72±0.08	3.59±0.07	3.56±0.10	ns
Fore and Hind Shanks Percentage (%)	1.95±0.04	1.99±0.06	1.98±0.07	ns
Liver Percentage (%)	1.75±0.20[a]	1.41±0.04[b]	1.26±0.04[b]	**
Testis Percentage (%)	0.17±0.01	0.16±0.01	0.17±0.01	ns
Tail Percentage (%)	0.25±0.02	0.23±0.00	0.24±0.01	ns
Lung Percentage (%)	0.98±0.06	0.87±0.03	0.85±0.03	ns
Spleen Percentage (%)	0.18±0.01	0.17±0.01	0.17±0.01	ns
Heart Percentage (%)	0.47±0.01	0.45±0.02	0.44±0.01	ns
Kidney Percentage (%)	0.85±0.03	0.84±0.07	0.91±0.04	ns

[1]The weights of noncarcass components were presented as a percentage of slaughter weight,*: P<0.05, **: P<0.01, ns: Nonsignificant, [a,b]: Means followed by a different letter within a line are statistically different.

gains for Holstein Friesian males were also reported by other researchers [19,20,23]. The results of the current study and other studies are in accordance with the growth pattern of cattle in which young animals have faster growth rate, and the growth slows down with advancing age, and it minimizes at sexual maturity.

Findings concerning overall fattening performance traits along with feed intake and FER values of bulls suggested that fattening performance parameters were improved numerically, as the initial fattening age decreased. Similarly, better fattening performance of young Holstein Friesian cattle compared to older ones was already reported by Koç and Akman [24], Karakök and Özkütük [25], and Aydin et al. [6]. The overall results are in harmony with the fact that young animals mainly produce muscles and bones at the beginning of their

Table 7. Least square means and standard errors for carcass measurements of Holstein Friesian bulls

Carcass Measurements	Young Group N=6 $\bar{X}$±$S_{\bar{X}}$	Middle Aged Group N=10 $\bar{X}$±$S_{\bar{X}}$	Older Group N=8 $\bar{X}$±$S_{\bar{X}}$	Significance
Chest Depth	43.8±0.5[b]	48.5±0.7[a]	49.5±0.4[a]	**
Carcass Length	142.2±1.9[b]	150.5±1.5[a]	152.9±1.9[a]	**
Length of Round	74.2±1.4[b]	80.2±1.0[a]	82.0±0.7[a]	**
Width of the Round (Medial Side)	40.3±1.0[b]	43.4±1.0[a]	44.0±0.7[a]	*
Width of the Round (Lateral Side)	21.5±0.3	22.8±0.6	22.9±0.7	ns

*: P<0.05, **: P<0.01, ns: Nonsignificant, [a,b]: Means followed by a different letter within a line are statistically different.

Table 8. Least square means and standard errors for chemical composition of MLD[1] of Holstein Friesian bulls

Chemical Composition	Young Group N=6 $\bar{X}$±$S_{\bar{X}}$	Middle Aged Group N=10 $\bar{X}$±$S_{\bar{X}}$	Older Group N=8 $\bar{X}$±$S_{\bar{X}}$	Significance
Protein (%)	20.9±0.2[b]	21.02±0.2[b]	21.6±0.1[a]	**
Fat (%)	1.52±0.15	1.48±0.16	1.42±0.7	ns
Dry Matter (%)	24.4±0.0	24.5±0.0	24.3±0.0	ns
Ash (%)	1.08±0.02	1.11±0.01	1.08±0.01	ns

[1]MLD: *musculus longissimus dorsi*, **: P<0.01, ns: Nonsignificant, [a,b]: Means followed by a different letter within a line are statistically different.

life. Then, they start to make and to accumulate fat with advancing age. The production of the protein requires less amount of energy compared to manufacturing of body fat [1]. Therefore, the young animals use nutrients more efficiently to produce muscles and bones compared to producing body fat, and, finally, the FER values become better for the animals at young age.

Hot and cold carcass weights of bulls in middle aged and older groups were heavier than these in YG. These differences could be attributed to greater final and slaughter weights of the animals in MAG and OG. The result was in accordance with the findings of Ozluturk et al. [26] and Diler et al. [22] who reported that carcass weights increased with increasing slaughter weights. Although no significant difference determined for hot and cold dressing percentages in the current study, the hot and cold carcass dressing values slightly increased with increasing initial fattening age. The result is comparable with finding of Litwinczuk et al. [27] who reported an increase of dressing percentage along with increasing slaughter weights of bulls.

As long as animals get older, amount of carcass fat increase. Therefore, Irshad et al. [28] reported that young bulls produced the leanest carcass. In contrast to the report, differences concerning carcass fatness parameters (percentage of kidney, pelvic and heart fat, SEUROP fatness scores, subcutaneous fat thickness over MLD and marbling scores) among the initial fattening age groups were not statistically significant. The insignificant differences could be attributed to rather small variations among different age groups of the bulls used in the current study. The finding was also in harmony with results of Gill et al. [29], Ozluturk et al. [26], and Ustuner et al. [30].

MLD areas along with MLD area per 100 kg carcass weight were significantly ($p < 0.01$) affected by initial fattening ages. Additionally, and MLD area and SEUROP carcass conformation scores of the Holstein Friesian bulls increased numerically as the initial age of fattening of the groups advanced (Table 5). Results reported by Nogalskiet al. [31] are consistent with the findings of the present study. The MLD area and SEUROP carcass conformation scores indicate muscularity of a beef carcass, and they are related to each other. Therefore, responses of MLD area and SEUROP carcass conformation scores to the ages at feedlot entry were naturally similar.

Results of the WBSF measurements demonstrated that tenderness of MLD samples obtained from YG, MAG, and OG might be considered within acceptable limits [(less than 9 lb (4.1 kg)]. In the current study, WBSF values of all age groups were similar as reported by Ustuner et al. [30], and the finding could be attributed to similar fatness level in three initial fattening age groups.

Initial fattening ages had significant effects on percentage of liver weight ($p < 0.01$) and hide weight ($p < 0.05$). On the other hand, the rest of the noncarcass components were not affected by feedlot entry ages. The results indicated that weight gain of the whole animal's body was parallel with the weight gains of the most of the noncarcass components.

Based on the findings of the study, it was determined that all carcass measurements, such as carcass length, chest depth, the width of the round from lateral and medial sides as well as length of round increased with the advancing initial fattening age as reported by Aydin et al. [6], Ozluturk et al. [26].

Findings of the study demonstrated that different initial fattening ages had a significant ($p < 0.01$) effect on the percentage of protein value of beef samples in favor of the older group, while no significant effect was determined on percentage of crude fat, dry matter, and ash values. Similar results for percentage of protein of MLD muscle were reported by Schoonmaker et al. [32] and Yim et al. [33]. Additionally, Schoonmaker et al. [32] also reported insignificant differences concerning percentage of fat and moisture of MLD samples among the age groups at feedlot entry.

5. Conclusions

In conclusion, it was determined that Holstein bulls in the YG had higher weight gains and better FER compared to other groups. On the other hand, the animals entered feedlot at the age of 15–17 and 12–14 months were superior to YG in terms of final fattening weights, slaughter weights, hot-cold carcass weights as well as carcass measurement because of their advanced ages at feedlot entry. Besides, measurements of the carcass muscularity including area of MLD, SEUROP carcass conformation scores of the bulls in the middle aged and older groups were superior to Holstein Friesian bulls in the YG. However, most of the other carcass traits, percentage of noncarcass components, and chemical composition of beef samples from different initial fattening age groups were not significantly different. In other words, earlier ages at feedlot entry resulted in accelerated weight gain of Holstein Friesian bulls reared in high altitude as well as harsh environmental conditions of the Eastern Turkey during the fattening period, improved FER and produced young, higher marbled beef but with lower carcass weights and carcass sizes.

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